



## **HIGHLIGHTS ON THE HISTORY OF SMALLPOX EPIDEMIOLOGY AND ERADICATION IN THE SUDAN**

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### **Abstract:**

*Smallpox is an ancient disease and was present in Africa, Asia and Europe since 400 BC. It is unclear whether smallpox was indigenous to Africa or was introduced early on. Sudan had a great experience in eradication phase of smallpox diseases. This study aimed to highlight the epidemiology of smallpox in terms of number of cases and geographical distribution, identify the local and global effort generated and determine the lessons learned from that experience in surveillance field in Sudan. To obtain our information we review articles online and reports from WHO store focusing on following key words (smallpox, eradication, Sudan). The health authorities have intensified smallpox control and vaccination programs during 1950 – 1962 whereby the incidence of cases reduced to 117 cases with three were imported cases in 1960, these in contrast 517 in 1959 and 3,030 in 1953 -1954. In 1969 for the campaign, 30 vaccination units were constituted, approximately 10 for each of 3 provinces (Blue Nile, Darfur and Kordofan), each unit comprising 6 smallpox and 3 BCG vaccinators plus supervisors. The units moved systematically through the province. The smallpox vaccinators went from house to house. The epidemiological data strongly support the belief that transmission in the Sudan was interrupted in 1962 and endemic smallpox did not recur until after the importations of 1967-1968. In September 1972, during a seminar in Addis Ababa, it was proposed that Sudanese and Ethiopian teams should be granted permission to cross the border without hindrance when undertaking search operations. Great job has been done to eradicate smallpox globally and especially in Sudan, and no doubt the lessons learned from the experience of smallpox eradication constitute strong concrete and base for managing health services in Sudan especially in epidemiology field by providing platform for surveillance of epidemic diseases.*

### **Keywords:**

*Smallpox, eradication, Sudan, epidemiology*

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## 1. INTRODUCTION

Smallpox is an ancient disease and was present in Africa, Asia and Europe since 400 BC. It is unclear whether smallpox was indigenous to Africa or was introduced early on. By 600 AD, smallpox was widespread in North Africa, and probably moved into West Africa by virtue of the caravan trade that crossed the Sahara desert. In addition to the disease arriving from across the desert, it was also introduced and reintroduced on the coast by foreign ships.

In 1721, a deadly epidemic of smallpox broke out in Boston. All around the city, people were dying painful deaths, covered all over their bodies with oozing, pus-filled sores. The disease was terrifying not just for the astonishing number of people it killed, but also because it was so misunderstood. During this period of time, science existed alongside superstition, and medicine next to magic. People were not clear about how the disease was transmitted, and because of that, virtually nothing could be done to prevent it. Smallpox was an equal opportunity killer.

In 1796, Edward Jenner conducted an experiment that would change the way the West dealt with smallpox, and that would set the stage for eradication attempts nearly two hundred years later. In that year, he made the observation that milkmaids in England were never stricken with smallpox. Rather, they suffered from “cowpox” lesions all over their hands and arms due to their constant contact with the cows they milked. Jenner guessed that the women’s exposure to cowpox granted some degree of immunity to the related smallpox disease. (In fact, smallpox is the human form of cowpox, and the disease mutated once cattle were domesticated and there was greater contact between humans and cows.)

## 2. EPIDEMIOLOGICAL ASPECT OF SMALLPOX

An acute infectious disease caused by *variola virus*, and clinically characterised by sudden onset of fever, headache, backache, vomiting and sometime convulsions, especially in children .in the third day of fever ,a typical rash appears which centrifugal in distribution and passes through successive stages of macule ,papule ,vesicle ,pustule and scab with subsequent scarring. It is useful to consider the epidemiological factors which have led to the eradication of smallpox which included ,no known animal reservoir, no long term carrier of the virus ,live long immunity after recovering from the disease ,easy case detection and high effective vaccine with easy administrative were available<sup>(1)</sup>.

Generally, direct and fairly prolonged face-to-face contact is required to spread smallpox from one person to another. Smallpox also can be spread through direct contact with infected bodily fluids or contaminated objects such as bedding or clothing. Rarely, smallpox has been spread by virus carried in the air in enclosed settings such as buildings, buses, and trains. Humans are the only natural hosts of variola. Smallpox is not known to be transmitted by insects or animals. A person with smallpox is sometimes contagious with onset of fever (prodrome phase), but the person becomes most contagious with the onset of rash. At this stage the infected person is



usually very sick and not able to move around in the community. The infected person is contagious until the last smallpox scab falls off<sup>(2)</sup>.

To control the spread of a smallpox outbreak, the priority of any response plan must be ring vaccination (vaccinating anyone in a prescribe area who could be susceptible) and the isolation of those who are already infected. It should be remembered that patients are not infectious during the early stage of the disease. They only become infectious with the onset of fever, and remain so until the scabs have healed. Suspected cases must be physically isolated and all people with whom they have come into contact must be identified and vaccinated. Experiences from the WHO eradication campaign have shown that a strict monitoring system can break the chain of transmission, provided that there is a rapid response to new cases, that the necessary infrastructure to isolate patients is in place, and that everyone who has come into contact with the infected person can be vaccinated. However, epidemiological models show that the absence of immunity against smallpox in Europe would necessitate the vaccination of the entire population or, at the very least, of those in endemic regions so as to control the outbreak<sup>(3)</sup>.

### **VARIOLATION (INOCULATION)**

The Chinese practiced the oldest documented use of variolation, dating back to the fifteenth century. They implemented a method of "nasal insufflation" administered by blowing powdered smallpox material, usually scabs, up the nostrils. Various insufflation techniques have been recorded throughout the sixteenth and seventeenth centuries within China. According to such documentation, mild smallpox cases were selected as donors in order to prevent serious attack. Similar methods were seen through the Middle East and Africa. Two similar methods were described in Sudan during the late eighteenth and early nineteenth centuries. Both had been long established and stemmed from Arabic practices. Tishteree el Jidderi ("buying the smallpox") was a practice seen within the women of Sennar in Central Sudan. A mother of an unprotected child would visit the house of a newly infected child and tie a cotton cloth around the ailing child's arm. She would then haggle with the child's mother over the cost of each pustule. When a bargain was struck, the woman would return home and tie the cloth around her own child's arm. Variations of this practice included bringing gifts to the donor. The second method was known as *Dak el Jedri* ("hitting the smallpox"), a method similar to that used in Turkey and eventually transported into England during the early sixteenth century. Fluid was collected from a smallpox pustule and rubbed into a cut made into the patient's skin. This practice spread more widely through Africa. It may have also travelled with merchants and pilgrims along the middle-eastern caravan routes into Turkey and Greece.

### **3. HISTORY OF SMALLPOX IN SUDAN**

In 1954, WHO declared and considered that, smallpox a suitable subject on which to initiate a system of programs and concentrated action since it is matter of direct interest to majority of government and international hazard with many serious aspects .the available data showed roughly, 2,400,000 cases and 1,000,000 deaths from smallpox reported between 1940 to 1952.



And during the flowing four years 1950 – 1953 more than 93, 99 cases with 29,690 death have been reported. In Saudi Arabia and during the season of Mecca pilgrimages in 1944 outbreak has been reported and lasted in April 1950 and it was a repetition challenges each year (4).

### **ANGLO- EGYPTIAN SUDAN (1899-1956)**

During the Anglo-Egyptian period smallpox epidemics were reported during 1939 – 1940 these epidemics accrued with 553 – 515 cases respectively .another epidemic broken out in 1047 and 1948 in some provinces in Anglo-Egyptian Sudan with 807 and 1412 cases respectively ,A third and rather big epidemic started in 1952 with high numbers of Notifiable cases illustrated below .

Years	1951	1952	1953	1954
Cases	164	1250	3548	1786
Death	24	185	528	244

Source <sup>(4)</sup>

### **POST INDEPENDENCE ERA**

In september1959 Eastern Mediterranean regional office held the first meeting in Alexandria to address several public health issues included the situation of smallpox in the countries. **Dr. Ahemed Zaki** was the representative of Sudan and he was present the challenges and difficulties of applying the smallpox vaccination low in Sudan especially in rural and isolated area and most of the population in such places were not aware about the smallpox regulations. Additionally, he highlighted the importance of implementation of international health regulations to the support the efforts which applied in domestic regulations <sup>(4)</sup>.

In Sudan, smallpox was persist in epidemics feature for the reason that of many factors such as hundreds of people crossing the borders from West Africa to Saudi Arabia for pilgrimage, seasonal movement of the nomads seeking land and water additionally the opened border between other country made the mission complicated .below the numbers of reported cases during the period 1959 to 1965 <sup>(5)</sup> .

Year s	1959	1960	1961	1962	1963	1964	1965
Cases	336	162	95	70	26	0	74

Source <sup>(5)</sup>

The health authorities has been intensified smallpox control and vaccination programs during 1950 – 1962 .whereby the incidence of cases reduced to 117 cases with three were imported cases in1960,these in contrast 517 in 1959 and 3,030 in 1953 -1954.



A plan for the eradication of the disease over a period of four years has been prepared by the ministry of health ,country was divided to four zone in order to implement universal vaccination coverage zone by zone each year, the first phase of campaign was started in November 1961 and took place till March 1962 it was covering Kordufan and Darfur provinces with total population about 3,417,000. the world health organisation was provide technical and logistic support through supplying vehicles and sterilizer and others.

Fellowships were awarded to the director of the public health laboratory in Khartoum (1962) and the senior laboratory technician in charge of smallpox vaccine production to study the technique for the production of lyophilized vaccine (6).

#### 4. ACTIVE SEARCH OPERATIONS

Due to limited communication in some areas and inadequate numbers of health workers active search was applied to permit team to appraise the smallpox situation in large area in short period .experience had showed that school and market were specially productive places to obtain information about smallpox cases .

Equatoria provinces (1.4 million population ) experienced many of outbreaks because of the civil disturbances .in March 1972 when the crisis ended many areas in southern Sudan had become affected with small pox and threatening smallpox-free bordering countries included Kenya ,Zaire ,Uganda and central Africa of republic .surveillance team allocated from northern Sudan to support active search activities and intensified the activities during March 1972 to late 1972.no cases been reported during these period in all affected areas.

The experienced surveillance personnel revisited affected households in affected areas with three phase program to cover the most recent foci, border of affected areas and unvisited affected areas .these were designed to detect smallpox among the large numbers of refugees returning from bush bordering countries after the end of civil disturbance <sup>(7)</sup> .

#### 5. CHALLENGES TOWARD SMALLPOX ERADICATION IN SUDAN

The Sudan was diverse in character, with extensive desert throughout the north giving way to steppe and grassland in the central part of the country and to large marshes and tropical forest areas in the south-eastern and southern parts of the country. Nearly half of the Sudan's 12.9 million population (in 1967) live in the fertile, extensively irrigated areas of Khartoum, Kordofan and Blue Nile rivers. Across the country, through Khartoum. Population movements, overall, were far more extensive than in other Saharan and sub-Saharan African countries. Civil war in the 3 southernmost provinces, which began at the time of independence in 1956, when tribal populations revolted against traditional leadership, was another serious problem. An estimated 50 000-100 000 Sudanese refugees from Equatoria Province lived in northern Uganda and Zaire but regularly moved in and out of the Sudan (8)



## 6. SMALLPOX IS REINTRODUCED INTO THE SUDAN

The first of what were thought to be imported outbreaks occurred in Khartoum in a temporal sequence moving from south to north, suggested that the series of outbreaks had originated from an importation with subsequent spread in a country otherwise free of smallpox.

To control the early 1968 outbreaks, mass vaccination campaigns were conducted in April and May: 452 256 persons were vaccinated in a single month in Upper Nile Province, 23 005 in Kassala Province and 638 015 in Blue Nile Province-in all, more than a million people. Few vaccinations had been performed in Upper Nile Province during the 1961-1 963 campaign, and the 1968 campaign reflected this. Of those aged 1-4 years, 72% received primary vaccination, as did 61% of the whole population. Primary vaccines accounted for only 24% of the total in Kassala Province and for only 18 % in Blue Nile Province. The last cases in these outbreaks were detected in Tune. Over the next 5 months, no further cases were reported (8)

## 7. THE NATIONAL MASS VACCINATION CAMPAIGN

Considering the size of the country and the extensive movement of population in the Sudan, it was recognized that an effective house to house, the assembly of large numbers of people at collecting points not being well accepted in most areas. Because of this, jet injectors were not useful. Although smallpox vaccination, administered with the bifurcated needle, was well suited to house-to-house vaccination, BCG vaccination, which required the use of a needle and syringe, was not. Among the problems was that the needles had to be flamed after each inoculation and the syringes repeatedly refilled from the vaccine vial. Accordingly, BCG vaccine was customarily administered at assembly points. To the smallpox staff, it appeared impracticable to try to combine a house-to-house vaccination campaign with one which called for the gathering of children at a collecting point, but the government, supported by the WHO Regional Adviser for Tuberculosis, decided on the combined programme. Unfortunately, the operational problems were never resolved.

For the campaign, 30 vaccination units were constituted, approximately 10 for each of 3 provinces (Blue Nile, Darfur and Kordofan), each unit comprising 6 smallpox and 3 BCG vaccinators plus supervisors. The units moved systematically through the province. The smallpox vaccinators went from house to house; the BCG vaccinators worked at a collecting point, vaccinating those up to 20 years of age. Each group prepared a separate set of records listing the name of the head of each household, the number of residents by age group and the number of vaccinations performed. Thus, two sets of forms were prepared in each village; no effort was made to reconcile them and, in fact, the records were not subsequently used either in assessment or in follow-up vaccination.

The plan for assessment of vaccination coverage and take rates was likewise inefficient. It called for a separate assessment team to examine one-quarter of those residing in 50% of the villages



after 1 week. This involved much more travel and manpower than the standard plan proposed in the 1967 WHO *Handbook for Smallpox Eradication Programmes in Endemic Area*, which suggested that 5-10% of the villages should be assessed. Progress was slow. Smallpox vaccinators averaged only 25-35 vaccinations a day in 1969 and 40 a day in 1970. Those performing BCG vaccinations averaged somewhat less than half this number. Overall Productivity was one-tenth to one-third that of other programmes in Africa (8).

## 8. ERADICATION CERTIFICATION IN SUDAN

By June 1970, 18 months after the programme had begun, only 5.3 million persons had been vaccinated, an estimated 68% of the population in the 3 provinces in which operations had been expected to be completed during the first year of the programme. Outside of these 3 provinces, the number of vaccinations recorded was equivalent to 5% or less of the population.

At the end of August, the programme stopped altogether when cholera cases were detected in the Sudan and the Ministry of Health decided to assign the teams to conduct a mass cholera vaccination campaign. Cholera vaccine offered little protection but was widely used nevertheless in many countries at that time. During November, no smallpox or ECG vaccinations were performed and, for many months thereafter a considerable number of teams and vehicles continued to be used for the administration of cholera vaccine. During December 1970, the smallpox-ECG vaccination campaign was gradually resumed but, as was noted in the populous Blue Nile Province, many villagers had left by that time to pick cotton. Entire villages were found empty or with very few residents. Vehicles were in critically short supply, some having been irreparably damaged by the bad roads, some remaining with cholera vaccination teams and some having been diverted to other uses by the Ministry of Health. In March 1971, the mass campaign finally concluded in the central provinces, more than 2 years after it had begun. The number of vaccinations reported to have been performed during 1969-1970 was greater than in 1968, but not commensurate with that expected of a staff of more than 500 (8).

The vaccination campaign shifted to the Northern provinces in 1971 and coincidentally the surveillance programme-such as it was-ceased when Dr Sulieman was reassigned to organize the vaccination campaign in Kassala Province. The WHO regional office replaced the WHO smallpox adviser by another adviser who, like his predecessor, was an ardent proponent of mass vaccination, with no understanding of the importance of the surveillance containment.

Search workers were assigned to travel on the river steamers and special search teams covered the border areas. Many rumours of cases were received, but none proved to be smallpox. In September 1972, during a seminar in Addis Ababa, it was proposed that Sudanese and Ethiopian teams should be granted permission to cross the border without hindrance when undertaking search operations. Both governments agreed and, thereafter, Sudanese teams investigating rumours of cases. Some times at the request of Ethiopian programme officers, travelled far into



Ethiopia. In November 1973 and in March 1974, the teams undertook special search and vaccination programmes over extensive areas, difficult of access, in Ethiopia (8).

In 1978 and after detailed consideration of all the documents and information available on smallpox eradication program, an independent field investigations was conducted by commission members and they were check out the available information in all province and they were build discussion with provincial eradication program (SEP) (9).

After the massive commission investigations have been conducted, the investigators conclude that, there is no evidence of endemic transmission or imported since the last reported case in 1972, surveillance system has been adequate enough to detect any cases might be occurred .finally they declared that the requirements for smallpox eradication as established by the WHO Expert commission in 1971 have been fully met and totally achieved 1<sup>(8)</sup>.

The commissioners formulating the recommendations and they took notes of the fact that smallpox transmission continued in some borders of the Sudan and Africans country in 1978.the main recommendations were:

- Surveillance system should e continued along the eastern border including red sea province till other African country free of smallpox.
- Primary vaccination continued till the global eradication has been certified.
- Vaccination certificate for smallpox should be required for travelers who have been in smallpox infected areas.
- All available evidence indicates that monkeypox it doesn't constitute a threat to smallpox eradication<sup>(8)</sup>.

## 9. SUMMERY

Following a mass vaccination campaign conducted during 1961-1963, the Sudan became free of smallpox and is believed to have remained non-endemic until 1968. However, the risk of the disease being imported into the country and becoming re-established was high. Traditional caravan routes between Mecca and the endemic countries of western Africa crossed the north-central area of the Sudan and, historically, many outbreaks had been traced to cases imported by such travelers there was some speculation that the Sudan had never been smallpox-free, that transmission had always continued in inaccessible areas of the war-torn southern provinces. In retrospect, however, the epidemiological data strongly support the belief that transmission in the Sudan was interrupted in 1962 and endemic smallpox did not recur until after the importations of 1967-1968.

Great job has been done to eradicate smallpox globally and especially in Sudan, and no doubt the lessons learned from the experience of smallpox eradication constitute strong concrete and base





for managing health services in Sudan .scientist setting many question in term to understand the possibility of smallpox re-emerging or transfer of anther *orthropox* viruses, and they also stressed out about the laboratory associated infection as same as when it was happened in Birmingham in 1978.Goloblisatin and urbanization increased the threat of using smallpox virus as bio-war or bioterrorism .in addition to many countries over the world suffering low standard of health service system, low community awareness, absent of knowledge and technical practices about emerging diseases and open border transportation ,and all epidemiologist agree that , all this factors increased the severity of emerging disease.

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